Space Weather Technical Forecast

Issued on Sunday 19 January 2025 at 00:49 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares expected, with slight chance of X-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with two M-class flares observed, peaking M1.7 at 18/0058 UTC from AR3964 in the northwest. This is the most active of the eight regions currently on the disc, but has recently seen activity ease with the weakening of its small delta-spot to the east of its main leader. Other regions of interest include AR3961 in the southeast, which is the largest region on the disc, but has remained relatively inactive despite ongoing growth and the development of a small delta-spot. AR3959 in the north-centre disc is also of interest, with a large leader spot with a strong magnetic field, but has remained inactive through this period.

A pair of weak CMEs were observed leaving the Sun associated with the M1.7 flare, and a subsequent likely filament lift. These have been assessed as likely missing Earth, but with a slight chance of a glancing impact late on day 2 (20 Jan).

Solar Wind / Geomagnetic Activity: Ongoing fast winds from CH09/- were observed. Solar wind speed, as measured by ACE and DSCOVR at L1 eased from elevated (550km/s) to slightly elevated (just below 500 km/s). Density remained at or below average. Interplanetary Magnetic field, Bt, was Weak, below 6nT with the north-south component also Weak, varying between +6nT and -5nT. Phi angle was negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 2-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at Background. High energy electron flux (greater than 2MeV) at GOES16 was mainly Moderate, peaking 706pfu at 18/1520UTC. The associated 24-hour fluence persisted below the Active threshold with a rising trend, reaching 2.2e7 integrated pfu at 19/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is expected, with isolated M-class flares and a slight chance of X-class flares. These most likely from AR3964 or perhaps AR3961.

Solar Wind / Geomagnetic Activity: There are no CME arrivals expected at Earth, however a glancing impact from the CME early on 18 Jan cannot be completely ruled out late on day 2 (20 Jan). Otherwise, current fast winds from CH09 are expected to persist day 1-2 (19-20 Jan), before

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gradually easing day 3 (21 Jan) onward. Mainly Quiet geomagnetic activity is expected, with Unsettled intervals and only slight chance of Active intervals.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to be at background, but with a slight chance of enhancement given the occurrence of any significant flares. GOES16 high energy electron flux is forecast to be Moderate to High, although the longevity of the periods of High is low confidence. The associated 24 hr fluence is expected to see a rising trend, with a slight chance of rising above the Active level by day 3-4 (21-22 Jan).

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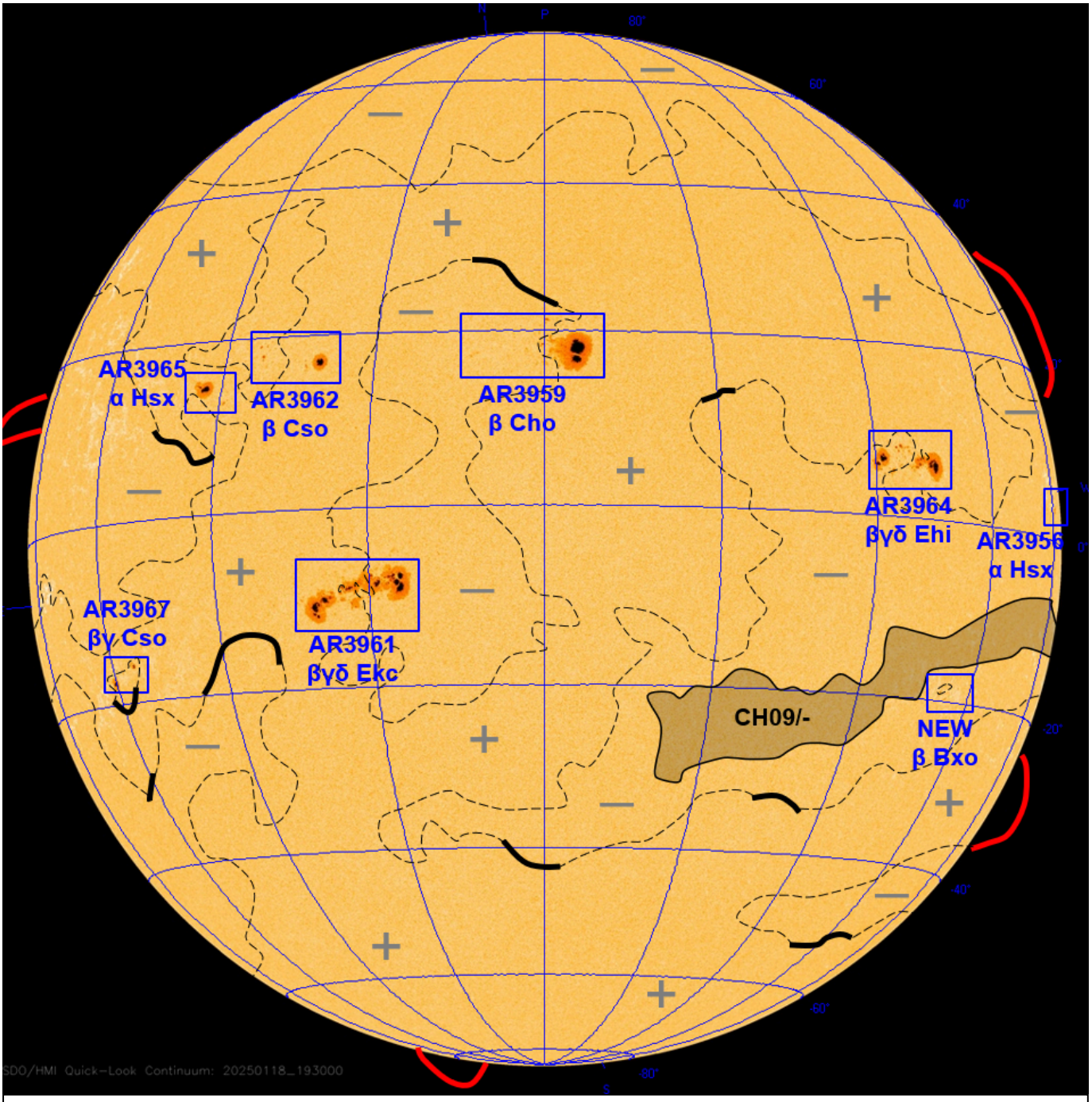
Figure 1: MOSWOC Solar Synoptic Map 18/2000 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are no CMEs expected to impact Earth. However a weak eruption from AR3964 early on 18 Jan is expected to pass close to Earth, likely just ahead and north of its orbit. This has a small chance to give a very slight glancing impact late on 20 Jan, as it passes nearby.

Solar winds are currently dominated by fast wind from the longitudinally wide CH09/-. Observed winds from this feature peaked near 550km/s late on 17 Jan, however the slightly elevated to elevated (450-550 km/s) solar winds are expected to persist day 1-2 (19-20 Jan), before gradually and erratically easing. This prolonged feature is supported by MOSOWC Enlil, although this is overestimating the strength of the wind slightly, and perhaps easing a little late from day 4 (22 Jan) onward.

Mainly Quiet geomagnetic activity is now expected, with Unsettled intervals and only slight chance of Active intervals. These perhaps most likely late on day 2 or day 3 (20-21 Jan), if any slight CME glance occurs.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	10	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Figure 2: MOSWOC Enlil showing ongoing fast wind enhancement.

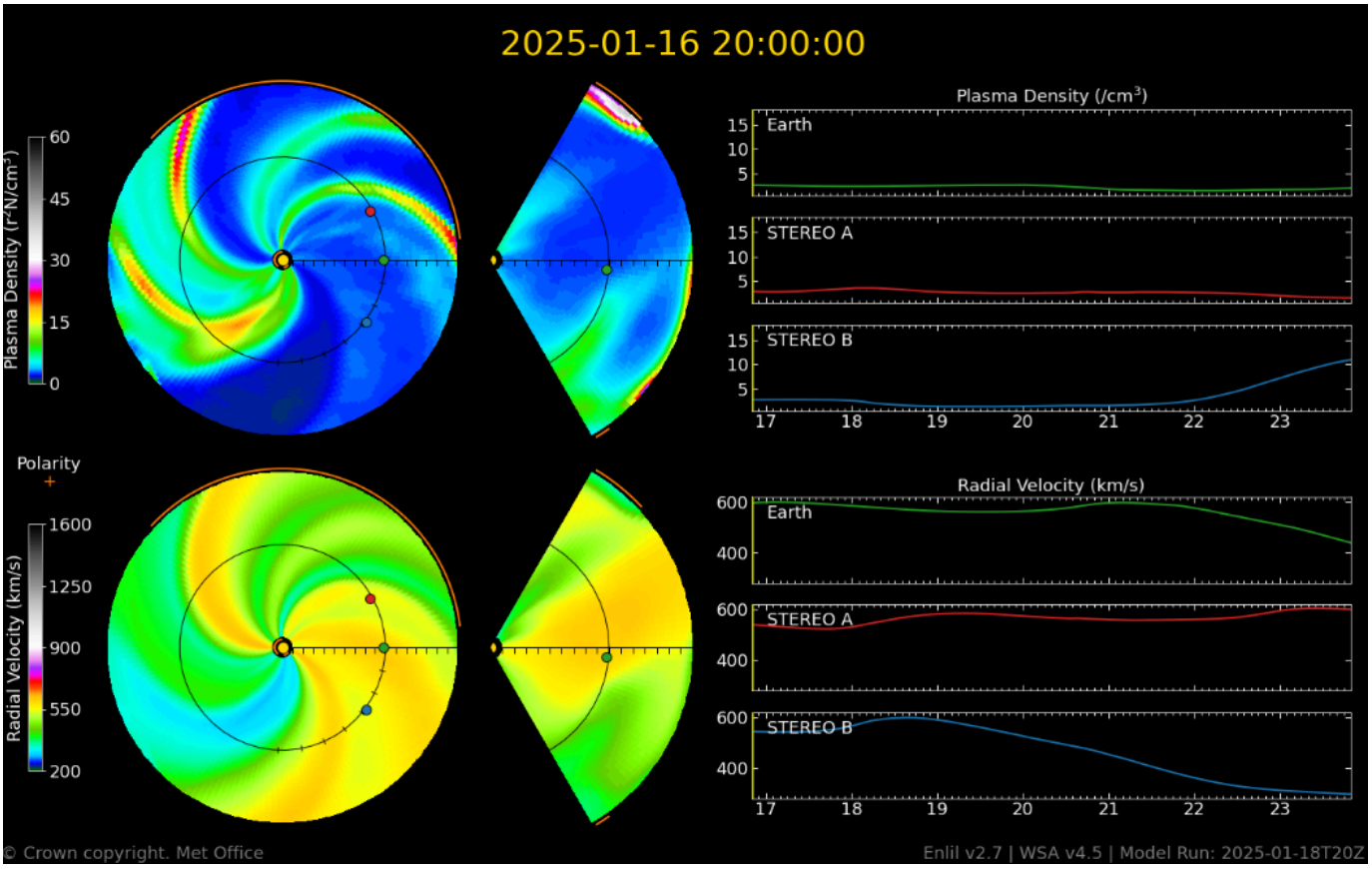
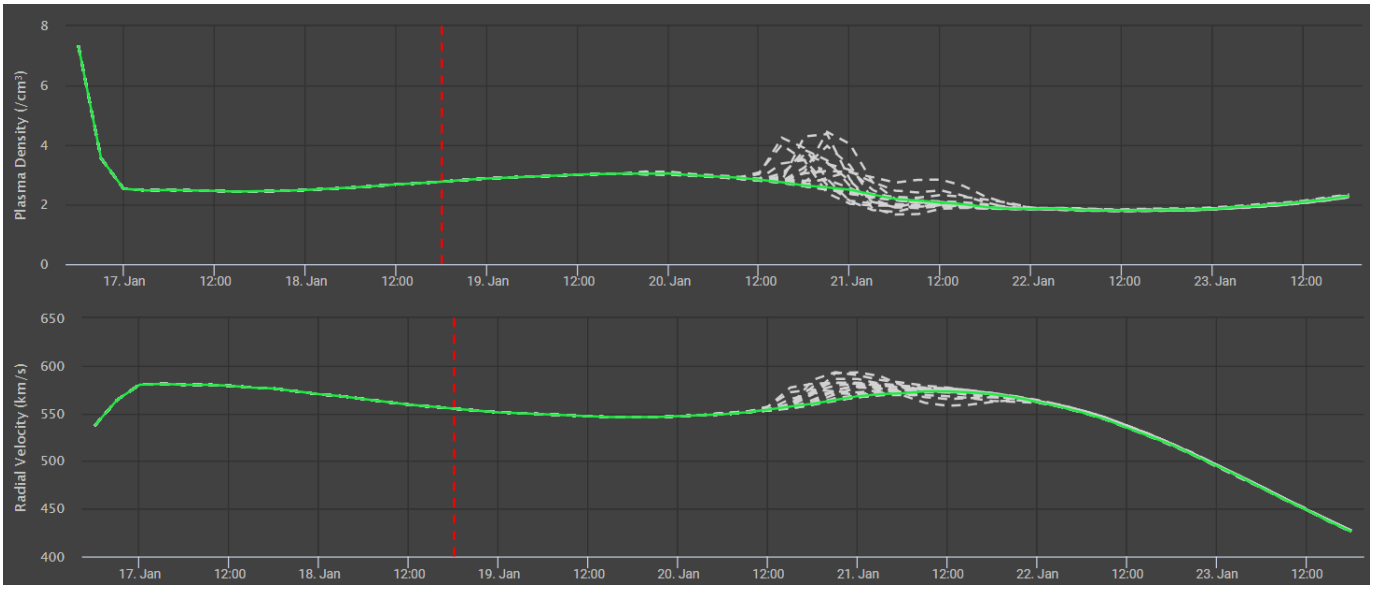


Figure 3: MOSWOC Enlil Ensemble showing slight chance of glancing impact late on day 2 (20 Jan)



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Radio Blackouts - X-Ray Flares

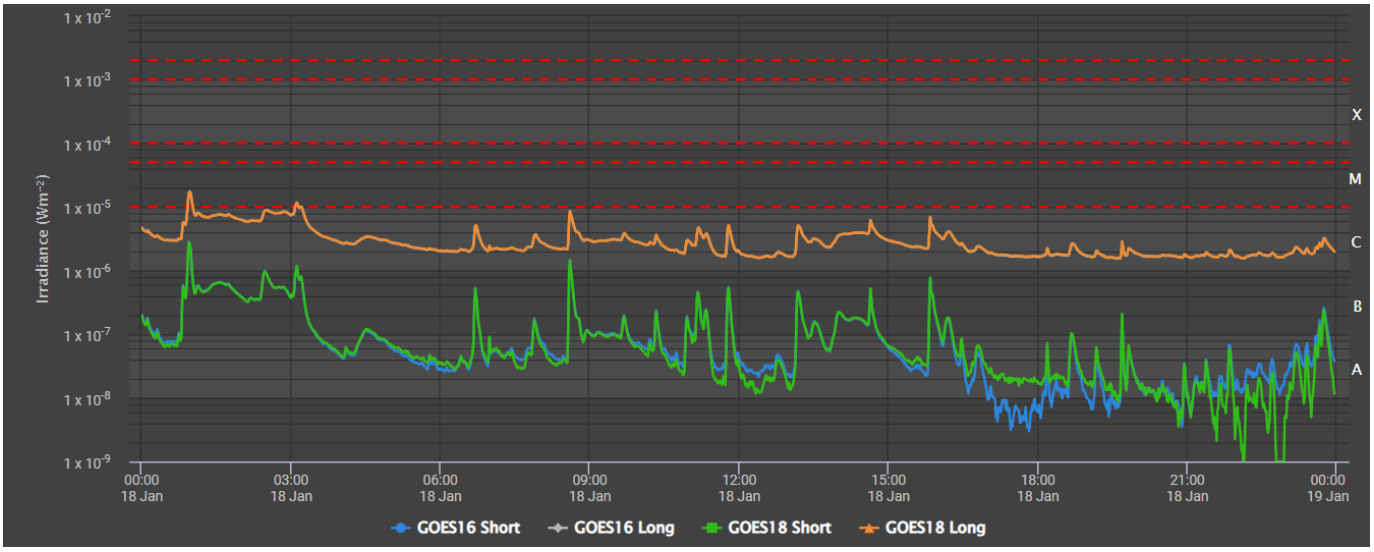
Moderate activity is expected to continue, with further isolated M-class flares expected and a slight chance of X-class flares.

There are eight sunspot regions on the Earth-facing disc, with three of particular note. AR3964 in the northwest has been the most active in recent days, but has seen its activity fade along with the weakening of a small delta spot spot in the intermediate spots east of its main leader. However, this delta spot is still visible, and alongside the ongoing development across the rest of the spot, continues to provide a potential for notable flaring.

The second of note is AR3961 in the southeast, which is the largest region on the disc. While this region has remained relatively quiet, this also contains a very small delta spot with its intermediate area, and continues to show some growth, and subsequent flare potential. The final region, is AR3959 in the north. While this is a magnetically much simpler region, this is dominated by a large leader spot which has an associated strong magnetic field. While the region is perhaps seeing some decline with its current surrounding spots, any further growth or development around this region would bring a further flare potential.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 (M Class)**	Yes	80	80	75	70
Very Active	**R3-R5 (X Class)**	No	20	20	15	10

Figure 4: GOES 16/18 X-ray Irradiance



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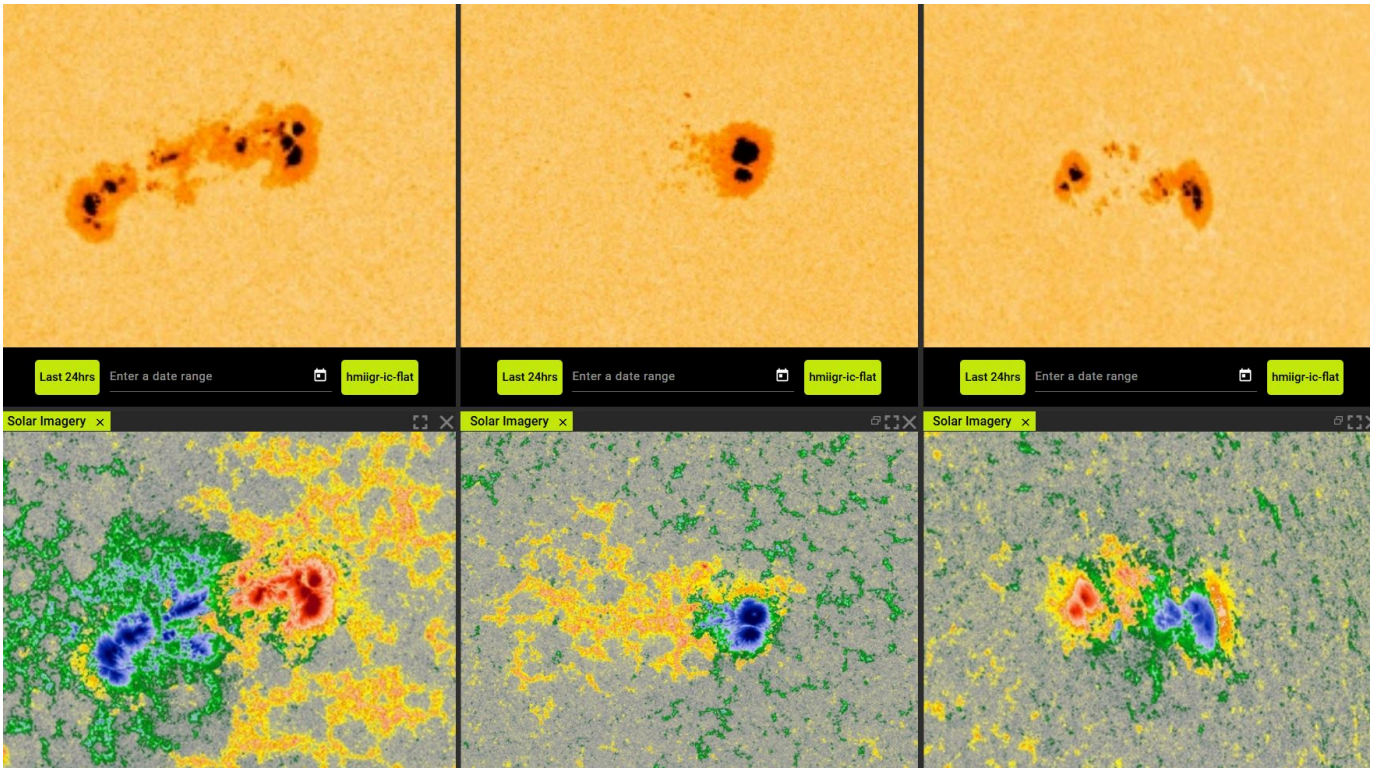
Solar Radiation Storms (High Energy Protons)

GOES18 high energy proton flux has persisted at Background. There is a slight chance of enhancement towards the S1 Minor Radiation Storm threshold given any notable flares. This includes any activity from AR3964 which is in a better connected location on the northwest disc, or from AR3961 in the southeast. AR3959 in the north, while currently less likely to produce notable flares, has a strong magnetic field suggesting that this is also a potential source should any destabilisation of this region occur.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: SDO hmi intensitygram (top) and magnetogram (bottom), of AR3961, AR3959 and AR3964 (left to right)



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High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has persisted at Moderate as a result of the recent extended period of slightly elevated to elevated solar winds. As these winds ease, any charging of the Radiation Belt at MEO is likely to expand outward, with the diurnal peak period at GEO likely to reach High. However, the longevity of these periods of High flux is currently low confidence. This is due to the lack of any notable geomagnetic activity leading to some uncertainty with the extent of the charging. Furthermore, there is a slight chance of a glancing CME arrival late on day 2 (20 Jan), which could help to drop out the observed flux at GEO.

Subsequently, the associated 24 hr fluence is most likely to stay below the Active (1e8 integrated pfu), but with rising trend, and a slight chance of rising above Active by day 3 (20 Jan), if more persistent High flux is observed and no CME arrival occurs. MOSWOC REFM supports this rising trend, and is currently giving reasonable guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	10	20	20
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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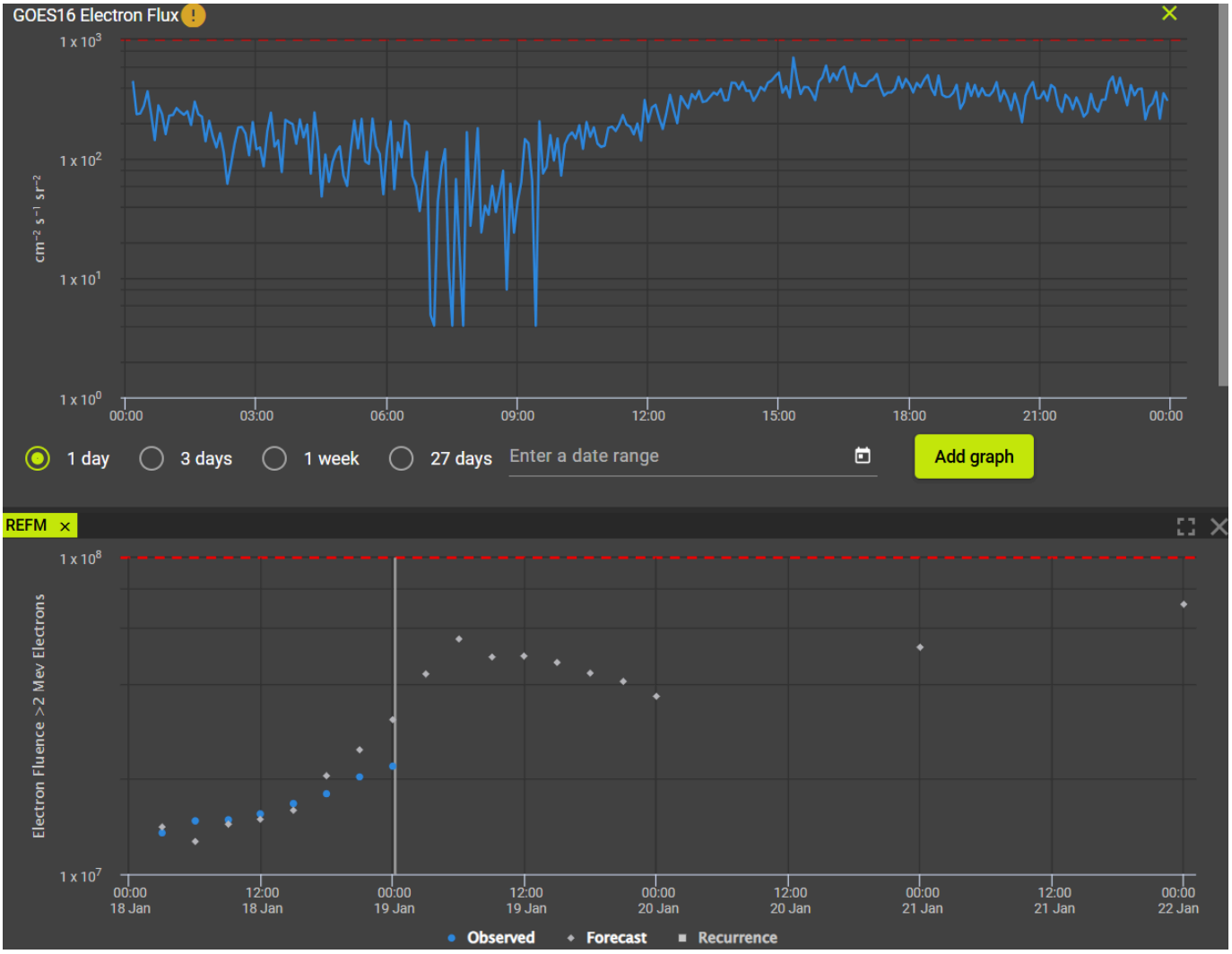
Figure 6: GOES 16 >2 MeV Electron Flux (top) and associated 24 hr Fluence with REFM (bottom)



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